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(54) **ELASTOMER MIDSOLE SHOE STRUCTURE**

ELASTOMERE ZWISCHENSOHLENSTRUKTUR

STRUCTURE DE SEMELLE D'USURE EN ELASTOMERE

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Description

BACKGROUND OF INVENTION

[0001] Field of Invention. This invention primarily relates to a midsole of an athletic shoe, particularly a running shoe. More specifically, it is directed to a lightweight molded, foamless, shock absorbing mid-sole that will adequately absorb a runner's impact forces and simultaneously provide durability, longitudinal stability and lateral support.

[0002] Related Art. For years, the athletic shoe industry has continually sought to improve athletic shoes. In large part, the focus has been upon comfort and absorption of the impact forces caused by the runner's heel striking the ground. Each prior art shoe and patent seem to focus upon the improvement of one or two important characteristics of the shoe design. For example, Cohen, U.S. Patent No. 4,754,559 appears to focus upon energy absorption and is primarily directed to the placement of "ribs" in the mid-sole or, alternatively, the insertion of tubes into the midsole. Cohen recommends the use of a "rubber like" material. Another patent, Derderian, *et. al.*, No. 4,535,553 focuses upon shock absorption and is directed to a midsole combination of an elastomeric foam and resilient insert member formed of Hytrel 4056.

[0003] *US-Patent No. 4,536, 974 discloses a mid-sole comprising a plurality of pairs of transverse ribs provided between the mid-sole to be mounted on a shoe and the outer sole. All of the ribs are provided with at least one bowed or convex surface running the length of the rib, wherein pairs of adjacent ribs together with the mid-sole and the outer sole define a cross section similar to a cylinder. The ribs are constructed from a rubber like or similar material, such that the ribs may be deflected, when the mid-sole structure is compressed.*

Summary of the Invention

[0004] *The present invention provides a foamless, lightweight mid-sole structure for an athletic shoe, said structure comprising;*
a mid-sole structure having a first, generally flat layer adapted to be mounted on an athletic shoe, generally cylindrical sections extending horizontally across the mid-sole and descending downwardly from said first flat layer to a second generally flat layer; said cylindrical sections together with said first and second layers defining a rear-foot section, a mid-foot section, and a fore-foot section, wherein said mid-foot section is relatively thin in cross-section relative to the rear-foot section, and the fore-foot section terminates in an apex near the front of the mid-sole structure, said mid-sole structure being formed of an elastomer having a ratio of plastic strain to elastic strain that is greater than 1.5:1, said cylindrical sections comprising a first type of cylindrical sections and a second type of cylindrical sections, said second type of cylindrical sections being disposed in the fore-foot section, said first type of cylindrical sections and said second layer being abridged to define a circumferential U-shaped and resilient impact section with a recessed center section, said U-shaped support section extending around the circumference of the heel of the shoe and forward to the fore-foot section, and the wall thickness of the cylindrical sections of the rear-foot section being thicker on the medial side of the shoe than on the lateral side.

[0005] *More particularly, the midsole is a molded midsole formed of an elastomer, wherein the elastomer is a co-polyester polymer-elastomer such as that manufactured and sold by E.I. duPont de Nemoirs. under the trademark Hytrel.*

[0006] In the preferred embodiment, the midsole takes the shape of a flexible upper layer separated from a lower, ground engaging layer by cylindrical shaped springs that are integrally joined to the upper and lower layers. This midsole has a rear-foot section in which the springs are in the shape of a plurality of truncated right cylindrical springs that extend from outside the lateral and medial sides of the shoe to a position underneath the shoe. Preferably, these individual cylindrical springs are not continuous, but are interrupted underneath the rear-foot section, and in conjunction with the lower layer, define a circumferential support surface that extends around the rear-foot section. The midsole of our invention also includes a mid-foot section as well as a fore-foot section. As will be shown, the cylindrical springs incorporated into rear-foot and the fore-foot sections are unique and fully provide the desired energy absorption, longitudinal and lateral support.

[0007] Accordingly, the objectives of this invention are to provide

1) a unique elastomeric compression midsole that will substantially reduce the weight of the traditional running shoe while maintaining, if not enhancing, the ability of the shoe to absorb the impact energy of the runner without transmitting it to his joints;
2) an elastomeric midsole unit that will provide substantial longitudinal stability as well as exceptional lateral support;
3) an elastomer midsole that will provide vertical softness and effectively cushion the runner's impact with the ground while simultaneously providing lateral stiffness;
4) an energy absorbing midsole that will not loose its resiliency over time;
5) a midsole whose resiliency and energy absorbing ability is not affected by moisture and perspiration;
6) an elastomer compression midsole that is most durable and not subject to tear propagation;
7) a midsole that will substitute stability and support for the mushy feeling left by some of the foam, air or fluid systems; and

DESCRIPTION OF THE DRAWINGS

[0008] The manner in which these objectives and other desirable characteristics can be obtained from this invention is explained in the following specification and attached drawings in which:

Figure 1 is a perspective view of a running shoe;
Figure 2 is a plan view of the preferred embodiment of the midsole of this invention;
Figure 3 is a sectional side elevation view of the preferred embodiment of the invention, the view taken along the lines 3-3 of figure 2;
Figure 4 is a perspective view of the preferred embodiment of the bottom of midsole of this invention;
Figure 5 is an elevational view taken along the lines 5-5 of figure 8;
Figure 6 is another side elevation view of a preferred embodiment depicting the invention in the flexed position;
Figure 7 is a side elevational view of the rear-foot section of a "preform" of our invention; and
Figure 8 is a side elevational view of the rear-foot section of the invention after it has been compressed to eliminate compression set of the plastic material.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0009] The preferred embodiment of our invention is illustrated in one intended environment in Figure 1. Such includes a running shoe 10 with an upper 12 that completely covers the foot and has the usual eyelets and lacing 14 on the top with a multilayered sole 20.

[0010] In this case, the multilayered sole 20 comprises the preferred embodiment of the midsole invention. As shown in figure 3, this midsole is divided into three sections along its longitudinal axis. These sections include a rear-foot section 24, a mid-foot section 26 and a fore-foot section 28. These sections and the entire midsole are molded as one integral piece. Preferably, they are injection molded with an elastomer having tensile characteristics such that the ratio of plastic strain to elastic strain is greater than 1.5 to 1. One such elastomer is a copolyester polymer elastomer manufactured and sold by E.I. du Pont de Nemoirs under the trademark Hytrel.® It is reasonably inert and significantly, it is quite durable. Moreover, this elastomer is not subject to tear propagation even when made in relatively thin cross sections. We prefer to use du Pont's Hytrel® composition no. 5556. (For a more complete description of this elastomer, see U.S. Patent No. 4,198,037 and the references cited therein).

[0011] From top to bottom, the midsole 20 of this invention includes a generally flat top ply or layer 32 of elastomeric. material from which depends generally cylindrical springs or cylindrical section 34 that are integrally joined to a flat ply or bottom layer 36 as shown in figures 3 and 4. The top layer 32 is also directly joined to the bottom layer 36 at the front 33 of the midsole 26, at the mid-foot section 26 and at the rear of the midsole as shown in figure 3.

[0012] In the rear-foot section, the cylindrical sections 34 are preferably truncated, right cylinder sections. These cylindrical sections 34 need not and do not extend completely across the rear-foot section 24. Instead, these cylindrical sections 34 are positioned in a generally U-shaped configuration about the circumference of the rear-foot section, leaving a void or recess 40 in the center of the rear-foot. The void and the resulting elimination of material provides substantial weight reduction. Significantly, the recess 40 and the weight reduction is permitted by the selected material and the manufacturing process described herein.

[0013] The illustrated interconnections of the upper layer 32 and the lower layer 36 provide excellent longitudinal stability. In, addition, the outward extensions 35 of the cylindrical sections 34 beyond the circumference of the upper 12 provides a wider platform for the runner's foot as shown Fig. 5. Significantly, this design of these extensions 35, their length and the direction of the cylindrical sections 34 is used, in part, to control the "roll" of the runner's foot. In addition the wall thickness of the cylindrical sections 34 of the rear-foot section is thicker on the medial side of the shoe than on the lateral side. This increased thickness is also used to provide the desired control of the motion of the foot.

[0014] The extension of the recess or void section 40 from the rear-foot section into the fore-foot section also provides torsional flexibility to the midsole and to the shoe. The forward extension of this recess is permitted since the strength of the material around the circumference of the shoe is more than adequate.

[0015] Support for the fore-foot section of the midsole is also provided by cylindrical springs as shown in figures 3,4 and 6. These springs 42 have a construction that is slightly different from the cylindrical sections 34 of the rear-foot section. One difference is that the cylindrical sections 42 extend across the entire width of the midsole. In addition, they are slightly tapered from the medial to the lateral side of the shoe, *i.e.*, the cross sectional thickness of the cylinder walls is greater on the medial side. In addition and to provide added flexibility, the cylinder springs of the fore-foot section are slit as at 44. As best illustrated in figure 6, this slit along the bottom surface of the cylinder spring and the midsole provides substantial, added flexibility to the fore-foot. Indeed, as the foot rolls farther forward, the cylindrical sections 34 are permitted to open and enhance the flexibility of the shoe.

[0016] In the manufacture of the invention, the midsole 20 is preferably injection molded. However, it is well known that the Hytrel® material will take a compression set. For this reason, our invention is molded into a preform, and is subsequently compressed to take that set. As is taught in U.S. Patent Application, Serial No.

07/823,930 entitled Radial Elastomer Compression Spring, now U.S. Patent No. 5,280,890, compression of the Hytrel® material not only causes the material to take a set, the compression also results in orientation of the molecular structure and enhances the spring characteristics of the material. The information of that patent is incorporated herein by reference.

[0017] The effect of this compression is illustrated in Figures 7 and 8. Figure 7 illustrates this taller preform that has been molded but not compressed. After the preform has been removed from the mold and allowed to coil and stabilize for up to twenty-four hours, it is then compressed, preferably to a solid position. Upon release of the compressive force, the upper and lower layers 32 and 36 will partially spring back, leaving the cylindrical sections 34 in an oval configuration as shown in figure 8. The midsole. takes a "set" in this position. Thereafter, these cylindrical sections 34 may be partially compressed during use by the runner, but as his weight is removed, the springs or cylindrical sections (34) will return to the "set" oval position shown in figure 8.

[0018] In as much as individuals vary in weight and size, there is no one manufacturing design for our invention that will accommodate all individuals. Consequently, some experimentation for each potential application will be required. Nevertheless, a primary, desirable design procedure to obtain the desired cylindrical wall thicknesses is to make two or more units with different dimensions, correlate their dimensions to their resulting spring rate and then interpolate or modify the dimensions until the desired spring rate is obtained.

[0019] Persons skilled in the art of plastic forming and compression spring design will discover that many modifications of our invention will also produce satisfactory results. Elastomers other than Hytrel® may be acceptable for some applications. Similarly, the dimensions of the cylinders and their wall taper as well as thickness may vary from design to design. In addition, the process of molding the compression spring of our invention can also include various modifications. As noted in figure 3, a lip 22 that conforms to the outer surface of the upper may be added around the circumference of the midsole. In addition, the top ply 32 of the midsole may extend completely across the recess to eliminate any void in the heel support. In addition, an abrasive resistant surface may be added to the lower surface 36 of the midsole. Finally, the recess 40 may extend throughout a major portion of the fore-foot.

Claims

1. A foamless, lightweight mid-sole structure for an athletic shoe, said structure comprising:

   a) a mid-sole structure (20) having a first, generally flat layer (32) adapted to be mounted on an athletic shoe, a plurality of generally cylindrical sections (34, 42) extending horizontally across the mid-sole (20) and descending downwardly from said first flat layer (32) to a second generally flat layer (36);

   b) said cylindrical sections (34, 42) together with said first and second layers defining a rear-foot section (24), a mid-foot section (26) and a fore-foot section (28); **characterized in that:**

   c) said mid-foot section (26) is relatively thin in cross-section relative to the rear-foot section (24), and said fore-foot (28) section terminates in an apex near the front of the mid-sole structure (20);

   d) said mid-sole structure (20) being formed of an elastomer having a ratio of plastic strain to elastic strain that is greater than 1.5:1;

   e) said plurality of cylindrical sections (34, 42) comprising a first type (34) of cylindrical sections and a second type (42) of cylindrical sections, said second type being disposed in the fore-foot section, said first type (34) of cylindrical sections and said second layer being abridged to define a circumferential, U-shaped support and resilient impact section with a recessed center section, said U-shaped support section extending around the circumference of the heel of the shoe and forward to the fore-foot section (28); and

   f) the wall thickness of the first type (34) of cylindrical sections in the rear-foot section (24) being thicker on the medial side of the shoe than on the lateral side.

2. The mid-sole structure (20) for an athletic shoe as recited in claim 1 in which said second type (42) of cylindrical sections of said fore-foot section (28) extend generally perpendicular to the longitudinal axis of the mid sole shoe and include a slit (44) adjacent to the second surface layer (36) to enhance the flexibility of the mid-sole (20).

3. The mid-sole structure (20) for an athletic shoe comprising a shoe upper (12) and the mid-sole as defined in claim 1 in which said cylindrical sections (34) of the rear-foot section (24) take the shape of truncated cylinders and extend beyond the circumference of the shoe upper.

4. The mid-sole structure for an athletic shoe as recited in claim 1 in which said second type of cylindrical sections (42) of said fore-foot section are tapered from the medial to the lateral sides of the shoe.

5. The mid-sole structure (20) of claims 1 to 4, wherein said recessed center section (40) extends longitudinally of the mid-sole structure (20) for a major portion of its length.

6. The mid-sole structure (20) of claim 1, wherein at least some of the cylindrical sections (34, 42) and said second layer (36) are slit in a direction parallel to the major axis of said sections (34, 42) to enhance the flexibility of the mid-sole.

7. The mid-sole structure of claim 5, wherein said recessed center section (40) is formed by cut-outs of said first type of cylindrical sections (34) and of said second layer (36).

8. The mid-sole structure (20) according to any of the preceding claims, wherein the cross-sectional thickness of the cylinder walls of the second type of cylindrical sections (42) is thicker on the medial side of the mid-sole.

Patentansprüche

1. Eine schaumlose, leichte Zwischensohlenstruktur für einen Sportschuh, wobei diese Struktur umfasst:

   a) eine Zwischensohlenstruktur (20) aufweisend, eine erste im allgemeinen flache Schicht (32) angepasst, um an dem Sportschuh befestigt zu werden, eine Vielzahl von allgemein zylindrischen Abschnitten (34, 42), die sich horizontal über die Zwischensohle (20) und die sich zwischen der ersten flachen Schicht (32) und einer zweiten allgemein flachen Schicht (36) erstrecken;

   b) wobei die zylindrischen Abschnitte (34, 42) zusammen mit der ersten und der zweiten Schicht einen Hinterfußbereich (24), einen Mittelfußbereich (26) und einen Vorfußbereich (28) definieren,
   dadurch gekennzeichnet, daß:

   c) der Mittelfußbereich (26) im Querschnitt relativ dünn ist im Verhältnis zum Hinterfüßbereich (24) und das der Vorfußbereich (28) in einem Scheitelpunkt nahe der Vorderseite der Zwischensohlenstruktur (20) endet;

   d) wobei die Zwischensohlenstruktur (20) durch ein Elastomer gebildet wird, dass ein Verhältnis der plastischen Dehnung zur elastischen Dehnung von größer als 1,5: 1 aufweist;

   e) die Vielzahl von zylindrischen Abschnitten (34, 42) einen ersten Typ (34) von zylindrischen Abschnitten und einen zweiten Typ (42) von zylindrischen Abschnitten umfasst, wobei der zweite Typ im Vorfußbereich angeordnet ist und wobei der erste Typ (34) der zylindrischen Abschnitte und die zweite Schicht verkürzt sind, um einen umfänglichen, U-förmigen Unterstützungs- und federnden Zusammenpressabschnitt mit einem vertieften Mittelabschnitt zu definieren, wobei sich der U-förmige Unterstützungsabschnitt um den Umfang der Ferse des Schuhs und vorwärts gerichtet zum Vorfußbereich (28) erstreckt; und

   f) die Wanddicke des ersten Typs (34) der zylindrischen Abschnitte im Hinterfußbereich (24) auf der medialen Seite des Schuhs dicker ausgebildet ist als auf der lateralen Seite.

2. Zwischensohlenstruktur (20) für einen Sportschuh gemäß Anspruch 1, in der sich der zweite Typ (42) der zylindrischen Abschnitte des Vorfußbereiches (28) allgemein rechtwinklig zur Längsachse des Zwischensohlenschuhs erstreckt und einen Schlitz (44) benachbart zur zweiten Oberflächenschicht (36) aufweist, um die Flexibilität der Zwischensohle (20) zu steigern.

3. Zwischensohlenstruktur (20) für einen Sportschuh aufweisend, ein Schuhoberteil (12) und die in Anspruch 1 definierte Zwischensohle (20), in der die zylindrischen Abschnitte (34) des Hinterfußbereiches (24) die Form von schief abgeschnittenen Zylindern aufweisen und sich über den Umfang des Schuhoberteils hinaus erstrecken.

4. Zwischensohlenstruktur für einen Sportschuh gemäß Anspruch 1, in der sich der zweite Typ der zylindrischen Abschnitte (42) des Vorfußbereiches von der medialen Seite zur lateralen Seite des Schuhs verjüngt.

5. Zwischensohlenstruktur (20) gemäß den Ansprüchen 1 - 4, wobei sich der vertiefte Mittelabschnitt (40) längsweise über einen Hauptteil der Länge der Zwischensohlenstruktur erstreckt.

6. Zwischensohlenstruktur, (20) gemäß Anspruch 1, wobei zumindest einige der zylindrischen Abschnitte (34, 42) und die zweite Schicht (36) in einer Richtung parallel zur Hauptachse dieser Abschnitte (34, 42) geschlitzt sind, um die Flexibilität der Zwischensohle zu steigern.

7. Zwischensohlenstruktur gemäß Anspruch 5, wobei der vertiefte Mittelabschnitt (40) durch Ausschnitte aus dem ersten Typ der zylindrischen Abschnitte (34) und der zweiten Schicht (36) gebildet wird.

8. Zwischensohlenstruktur (20) gemäß einem der vorrangegangenen Ansprüche, wobei die Querschnittsdicke der Zylinderwände des zweiten Typs der zylindrischen Abschnitte (42) auf der medialen Seite der Zwischensohle dicker ist.

Revendications

1. Structure de semelle intercalaire léger sans mousse pour une chaussure de sport, ladite structure comprenant:

   a) une structure de semelle intercalaire (20) possédant une première couche de forme générale plane (32) adaptée pour être installée dans une chaussure de sport, une pluralité de sections de forme générale cylindrique (34; 42) qui s'étendent horizontalement en travers de la semelle intercalaire (20) et s'étendent vers le bas depuis ladite première couche plane (32) jusqu'à une seconde couche de forme générale plane (36);
   b) lesdites sections cylindriques (34, 42) définissant, conjointement avec lesdites première et seconde couches, une section (24) située au niveau de la partie arrière du pied, une section (26) située au niveau du milieu du pied et une section (28) située au niveau de la partie avant du pied;
   caractérisée en ce que:
   c) ladite section (26) située au milieu du pied possède une section transversale relativement mince par rapport à la section (24) située au niveau de la partie arrière du pied et ladite section (28) située au niveau de la partie avant du pied se termine par une pointe proche de l'avant de la structure de semelle intercalaire (20);
   d) ladite structure de semelle intercalaire (20) étant formée d'un élastomère dont le rapport de la déformation plastique à la déformation élastique est supérieur à 1,5:1;
   e) ladite pluralité de sections cylindriques (34, 42) comprenant un premier type (34) de sections cylindriques et un second type (32) de sections cylindriques, ledit second type étant disposé dans la section située au niveau de la partie avant du pied, ledit premier type (34) de sections cylindres et ladite seconde couche étant raccourci de manière à définir une section circonférentielle formant support en forme de U et section d'impact élastique pourvue d'une section centrale en renfoncement, ladite section de support en forme de U s'étendant autour de la circonférence du talon de la chaussure et vers l'avant en direction de la section (28) située au niveau de la partie avant du pied; et
   f) l'épaisseur de paroi du premier type (34) de sections cylindriques dans la section (24) située au niveau de la partie arrière du pied étant plus grande sur le côté médian de la chaussure que sur le côté latéral.

2. Structure de semelle intercalaire (20) pour une chaussure de sport selon la revendication 1, dans laquelle ledit second type (42) de sections cylindriques de ladite section (28) située au niveau de la partie avant du pied s'étend d'une manière générale perpendiculairement à l'axe longitudinal de la partie formant semelle intercalaire et comprend une fente (44) adjacente à la seconde couche superficielle (36) pour améliorer la flexibilité de la semelle intercalaire (20).

3. Structure de semelle intercalaire (20) pour une chaussure de sport comprenant une empeigne (12) et la semelle intercalaire selon la revendication 1, dans laquelle lesdites sections cylindriques (34) de la partie (24) située au niveau de la partie arrière du pied possèdent la forme de cylindres tronqués et s'étendent audelà de la circonférence de l'empeigne.

4. Structure de semelle intercalaire pour une chaussure de sport selon la revendication 1, dans laquelle ledit second type de sections cylindriques (42) de ladite section située au niveau de la partie avant du pied se rétrécissent depuis le côté médian vers les côtés latéraux de la chaussure.

5. Structure de semelle intercalaire (20) selon les revendications 1 à 4, dans laquelle ladite section centrale en renfoncement (40) s'étend dans la direction longitudinale de la structure de semelle intercalaire (20) sur une majeure partie de sa longueur.

6. Structure de semelle intercalaire (20) selon 1 revendication 1, dans laquelle au moins certaines des sections cylindriques (34, 42) et ladite seconde couche (36) sont fendues dans une direction parallèle à l'axe principal desdites sections (34, 42) pour améliorer la flexibilité de la semelle intercalaire.

7. Structure de semelle intercalaire selon la revendication 5; dans laquelle ladite section centrale en renfoncement (40) est formée par des découpes dudit premier type de sections cylindriques (34) et de ladite seconde couche (36).

8. Structure de semelle intercalaire (20) selon l'une quelconque des revendications précédentes, dans laquelle l'épaisseur en coupe transversale des parois cylindriques du second type de sections cylindriques (42) est plus grande sur le côté médian de la semelle intercalaire.

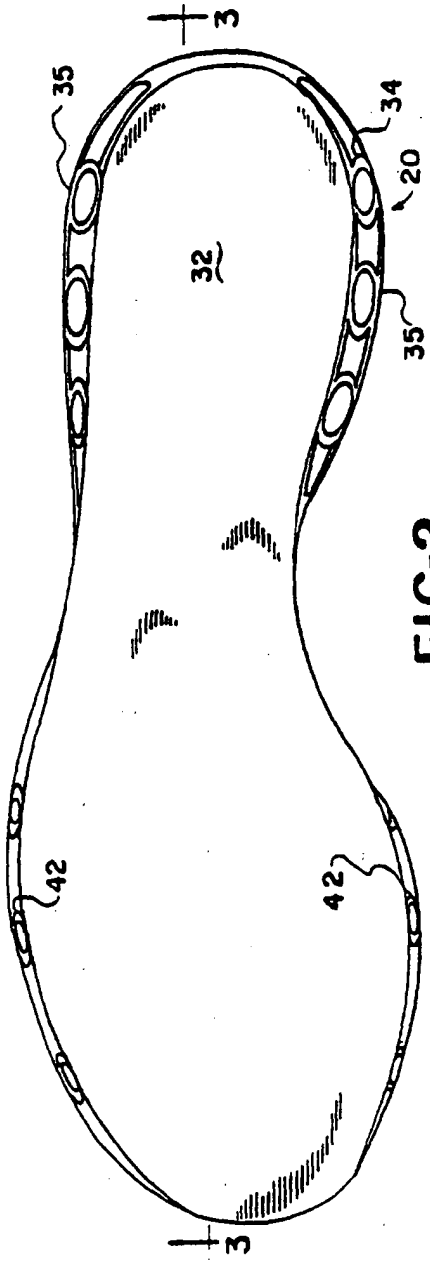

FIG-2

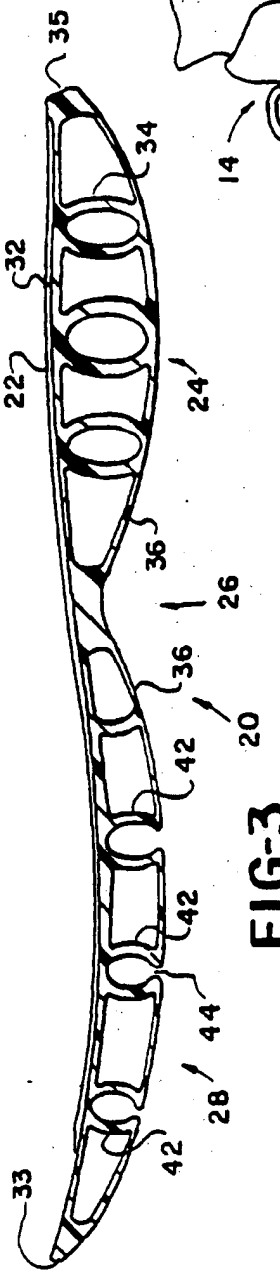

FIG-3

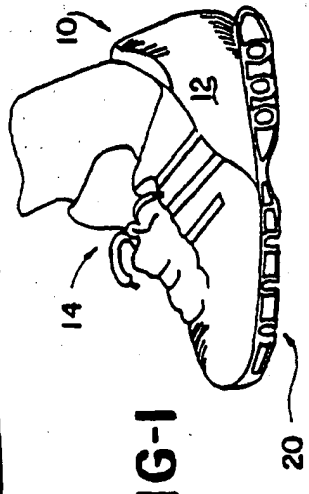

FIG-1

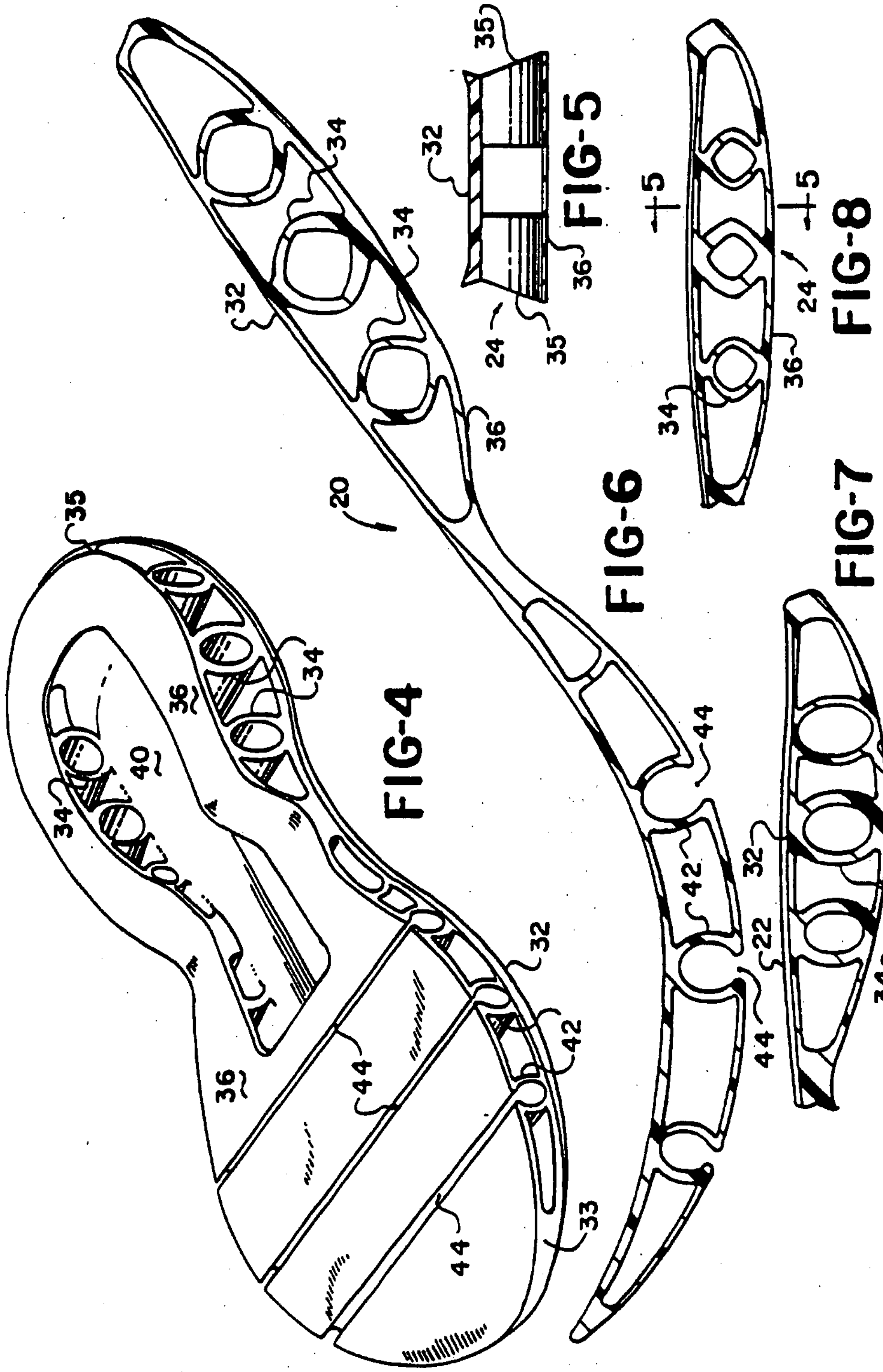
FIG-4
FIG-5
FIG-6
FIG-7
FIG-8
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